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Report prepared for:

Phytotoxicology Section
Air Resources Branch
Ontario Ministry of the Environment

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PHYTOTOXICOLOGY INVESTIGATION IN THE VICINITY OF HAMILTON BRICK, HAMILTON, ONTARIO - SEPTEMBER 9, 1991

INTRODUCTION

In 1986 and 1987, staff from the Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment conducted surveys to assess the condition of vegetation growing in the vicinity of Hamilton Brick in Hamilton, Ontario. The foliage of sensitive plant species in close proximity to the brick plant was found to have symptoms typical of fluoride injury. Samples collected during each of those visits confirmed that elevated concentrations of fluoride were present in the tissues of foliage. In 1991, the survey was repeated and the results of that survey are presented in this report.

FIELD INSPECTION

During the 1986 inspection, a set of 11 permanent sample stations was established for observation and collection of foliage samples. In 1991, the sample tree at Station 6 was no longer available, therefore a new station (Station 12) was established about 100 m to the west inside Gage Park. The sample stations are located as follows with respect to the kilns at Hamilton Brick and are shown in Figure 1.

Vegetation observation and sampling stations established in the vicinity of Hamilton Brick.

Station Number	Location	Position
1	Lawrence and Rosslyn	50 m N
2	Gage Park N of Rosedale Lawn Bowling	550 m NNW
3	Gage Park E of Maplewood	900 m NNW
4	Rosslyn and Montclair	350 m N
5	Kensington and Central	500 m N
6	Maple and Kensington	700 m N
7	Balmoral and Lawrence	100 m E
8	Ottawa and Justine	320 m E
9	Justine and Province	600 m E
10	Lawrence and London	350 m ESE
11	Lawrence and Province	600 m ESE
12	Gage Park W of Maple	700 m N

The stations noted above fall within a zone bounded roughly by Lawrence Avenue on the south, by Gage Street on the west, by King Street on the north and Graham Street on the east. The area encompasses Gage Park and a residential area of approximately the same area. The south limit was largely determined by the steep slope of the Niagara Escarpment.

At each station, injury to vegetation was assessed for typical fluoride injury. Triplicate samples of foliage of silver maple (*Acer saccharinum*) were collected at each station except Stations 1 and 2. At Station 1, single samples of foliage were obtained from Manitoba maple (*Acer negundo*), American Elm (*Ulmus americana*), Wild Grape (*Vitis riparia*) and Norway maple (*Acer platanoides* duplicate samples). Duplicate samples of silver maple were collected at Station 2.

LABORATORY METHODS

The samples were brought to the Phytotoxicology Laboratory for processing using a standard procedure. The samples were dried in an oven, ground in a Wiley mill and stored in glass bottles. They were then forwarded to the Ministry of the Environment Laboratory, Downsview, for chemical analysis to determine the fluoride and chloride concentration.

RESULTS

Injury assessments for 1991 as well as those for previous years for comparison purposes are included in Table 1. The injury observed was most severe in close proximity to the brick kilns. At several sites (1, 4, 11 and 12), injury appeared to be slightly more severe in relation to previous years.

The chemical analysis results for samples collected in all years are presented in Table 2. The results for 1991 are generally lower than those of earlier years. At Site 1, the fluoride content decreased in two species but increased in a second pair of species. Fluoride concentrations decreased by about half in comparison to 1986 at 5 other stations. Whereas only samples collected at one station (Station 3) contained fluoride in concentrations below normal background levels (Phytotoxicology Upper Limit of Normal for an urban area is 35 ug/g F) in both earlier years, there were four 4 stations which fell within the background concentration in 1991.

The highest concentrations were measured in samples collected at Stations 1, 7 and 10 which are located nearest to the brickyard. Contamination extended outside the brickyard approximately 700 m to the north and east.

Correspondence with the MOE Hamilton District office revealed that brick production at Hamilton Brick in 1991 was down considerably from the previous year. This undoubtedly contributed to generally lower fluoride concentrations in the tree foliage.

Because of the difficulty of separating fluoride-induced injury from that caused by road salt and drought, chloride analysis of the samples was also requested. Chloride concentrations ranged from 0.070% in wild grape to 1.467% in maple foliage. The two highest concentrations of chloride were found at Sites 7 and 10, the sites nearest to the brickyard. The third highest of the chloride values was found at Site 11. Because these three sites are fairly close together along the same street, they should experience very similar exposures to traffic and associated road salt. As Lawrence receives a greater volume of vehicular traffic than the nearby residential streets, the higher chloride values are expected from these three sites.

It is not possible to clearly differentiate the relative roles of fluoride and chloride in causing the observed damage. However, it is unlikely that the road sa alone was responsible at the concentrations observed. The concentrations of fluoride on the other hand are definitely adequate to cause the observed injury.

Conditions of reduced rainfall resulting in drought experienced in 1991 provided an added stress for the trees growing in the area. Such conditions might actually reduce fluoride uptake because the stomates on the foliage would be more tightly closed. In any event, the area under investigation is fairly limited and should therefore be exposed to uniform weather throughout. The gradient of injury showed clearly that the greatest injury and highest fluoride concentrations were found in proximity to the brickyard.

SUMMARY

A surveillance investigation of the vegetation growing in the vicinity of the Hamilton Brick operation on Lawrence Avenue in Hamilton was conducted by the Phytotoxicology Section on September 9, 1991. Injury to sensitive vegetation was observed in close proximity to the operation and was associated with elevated fluoride content of the foliage. The maximum fluoride concentration measured was 660 ug F/ g (dry weight basis) in the foliage. Despite a reduction in fluoride concentrations at over half of the stations, the degree of injury remained similar or was slightly enhanced in comparison with similar investigations conducted in 1986 and 1987. Foliar contamination and associated injury development was confirmed in an area extending approximately to 700 m north and east of the brickworks. A control order has been drafted to require Hamilton Brick to investigate and implement controls to further reduce fluoride emissions. This control order will be served if current control activities are not successful.

Table 1. **Injury to foliage in samples collected in the vicinity of Hamilton Brick, Hamilton, Ontario in 1986, 1987 and 1991**

Station	Species	Injury Severity **		
		1986	1987	1991
1	Manitoba Maple	---	Severe	Moderate
1	Norway Maple	---	Light-moderate	Light
1	American Elm	Moderate	Moderate-severe	**Severe**
1	Wild Grape	Moderate	Moderate	Moderate
2	Silver Maple	Trace	Trace-light	Trace
3	Silver Maple	Healthy	Healthy	Healthy
4	Silver Maple	Trace	Trace	**Light**
5	Silver Maple	Light	Trace	---
6	Silver Maple	Trace	Trace	---
12	Silver Maple	---	---	**Light**
7	Silver Maple	Moderate	Light	Light-moderate
8	Silver Maple	Light	Light-moderate	Light
9	Silver Maple	Trace-light	Trace	Trace
10	Silver Maple	Moderate	Moderate	Moderate
11	Silver Maple	Trace-light	Trace	**Light**

** Injury Severity Rating

Trace >0-1%
Light 2-10%
Moderate 11-35%
Severe >35%

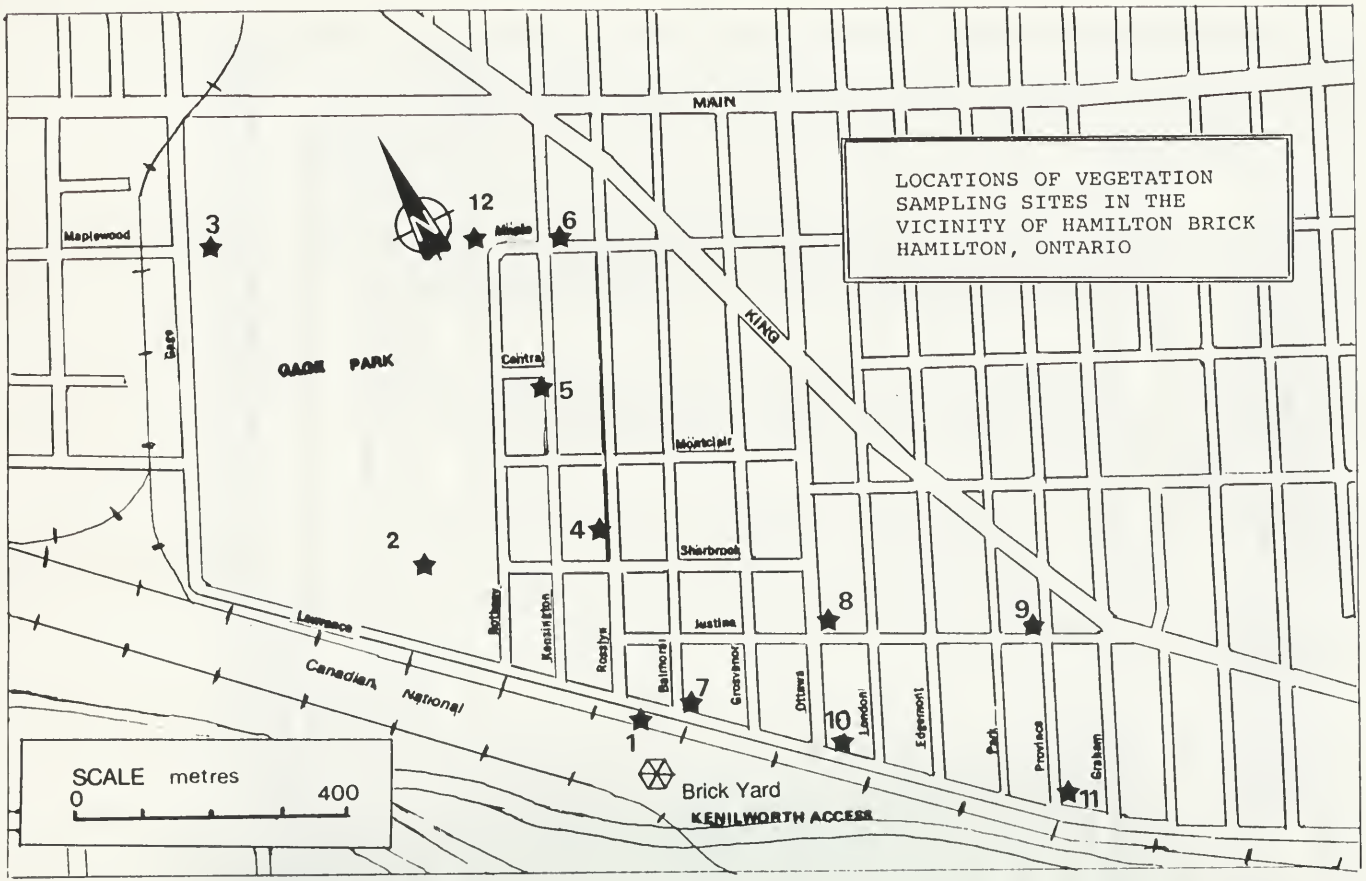
Ratings shown in bold font indicate greater injury than for previous surveys

Table 2. **Fluoride and chloride content of foliage samples collected in the vicinity of Hamilton Brick, Hamilton, Ontario in 1986, 1987 and 1991**

Station	Species	Fluoride Content *			Chloride Content (%)
		1986	1987	1991	1991
1	Manitoba Maple	---	**1100**	**230**	0.240
1	Norway Maple	---	**540**	**195**	0.550
1	American Elm	**400**	---	**660**	0.450
1	Wild Grape	**180**	---	**190**	0.070
2	Silver Maple	**40**	**44**	24	0.380
3	Silver Maple	17	20	10	0.166
4	Silver Maple	**105**	**100**	**54**	0.347
5	Silver Maple	**55**	**86**	23	0.157
6	Silver Maple	**40**	**36**	---	---
12	Silver Maple	---	---	14	0.507
7	Silver Maple	**820**	**600**	**327**	1.287
8	Silver Maple	**54**	**110**	**91**	0.813
9	Silver Maple	**41**	**73**	**50**	0.433
10	Silver Maple	**180**	**200**	**183**	1.467
11	Silver Maple	**53**	**56**	**60**	0.933

* Fluoride values are reported as ug/g dry weight for single samples in 1986 and 1987, arithmetic mean of triplicate samples (except Sites 1 and 2 as noted in text) in 1991. Chloride values are reported as percent dry weight.

Concentrations shown in bold font exceed the Upper Limit of Normal guidelines of 35 ug/g fluoride in urban foliage (See Appendix).


LOCATIONS OF VEGETATION SAMPLING SITES IN THE VICINITY OF HAMILTON BRICK HAMILTON, ONTARIO
MAIN
KING
OAKS PARK
Maplewood
Centra
Municipal
Sherbrook
Lawrence
Canadian National
Bothwell
Kensington
Rosslyn
Belmont
Justine
Grosvenor
Ottawa
London
Edgemont
Park
Province
Graham
Brick Yard
KENILWORTH ACCESS
SCALE metres
0
400
1
2
3
4
5
6
7
8
9
10
11
12

Appendix

Derivation and Significance of the MOE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a point source of pollution. Urban ULN guidelines are based on samples collected from developed urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (ref: Ontario Ministry of the Environment 1983, *Phytotoxicology Field Investigation Manual*). Chemical analyses were conducted by the MOE Laboratory Services Branch.

The ULN is the arithmetic mean, plus three standard deviations of the mean, of the suitable background data. This represents 99% of the sample population. This means that for every 100 samples which have not been exposed to a point source of pollution, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.